

Impacts of Climate Change on Water Resources: Research Performed at the University of Washington

A Brief Overview

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Talk Overview

- Where it started (for me)
- Institutional Resources
- Past Studies
- Gaining Consensus
- Conclusions

IPCC web sites

About IPCC

Activities

Calendar of Events

Publications

Presentations
& Graphics

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in all UN languages

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مرحبا Bienvenuto

User Guide to the IPCC
Website

How do I find information about
climate change on the IPCC

"Climate Change 2007"

The IPCC 4th Assessment Report
is coming out

A comprehensive and rigorous picture
of the global present state of knowledge
of climate change

Play

Paris, 2 February 07

The first volume will be released.

- ✓ What progress has been made in understanding and attributing climate change?
- ✓ What do observations of the atmosphere, oceans, sea level, snow and ice tell us?
- ✓ How has climate been behaving in the last hundreds of thousands years?
- ✓ Which are the projections of future changes?

Find the latest information on "The Physical Science Basis of Climate Change" in Working Group I report

The Intergovernmental Panel on Climate Change (IPCC) has been established by WMO and UNEP to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation. It is currently finalizing its Fourth Assessment Report "Climate Change 2007". The reports by the three Working Groups provide a comprehensive and up-to-date assessment of the current state of knowledge on climate change. The Synthesis Report integrates the information around six topic areas. [More](#)

Working Group I "The Physical Science Basis"

- > [See chapters outline](#)
- > **Acceptance and approval at the 10th Session of Working Group I, 29 Jan - 1 Feb 2007, Paris, France**
[Information for participants](#)
- > Release: 2 February 2007

Working Group II "Impacts, Adaptation and Vulnerability"

- > [See chapters outline](#)
- > Distribution of final draft report 22 December 2006
[Letter to governments](#) - comments on SPM invited by 16 February 2007
[Correction](#)
- > **Acceptance and approval at the 8th Session of Working Group II, 2-5 April 2007, Brussels, Belgium**
[Information for participants](#)

Working Group III "Mitigation of Climate Change"

Information for Press

WG1 Release



- > [22 Jan 07 - Media Advisory](#)

- > [2 Feb 07 Press Information Note](#)
- > [Download Summary For Policymakers](#)
- > [Access the WEBCAST of the Press Conference](#)

Information for Authors

- > [Finalizing graphics and maps for a scientific report](#)
Graphics manual and information about support for graphics work
- > [Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties](#)

The Synthesis Report (SYR)

Climate Change and Water Resources

- Lettenmaier and Burges (1979), Lettenmaier and Sheer (1991)
- Research Contract with IWR to look at 5 river basins, of various sizes and uses, to determine potential impacts of climate change on Corps' missions.
- Green River, Missouri River, Boston Water Supply, ACF, Savannah River





Climate Science
in the Public Interest

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Climate Impacts Group

Box 354235
Seattle, WA



The **Climate Impacts Group (CIG)** is an interdisciplinary research group studying the impacts of natural climate variability and global climate change ("global warming") on the U.S. Pacific Northwest (PNW). Through research and interaction with regional stakeholders, the CIG works to increase the resilience of the Pacific Northwest to fluctuations in climate.

The CIG's research focuses on four key sectors of the PNW environment: water resources, aquatic ecosystems, forests, and coasts.

The CIG is unique in its focus on the intersection of climate science and public policy. We perform fundamental research on climate impacts and work with PNW planners and policy makers to apply this information to regional decision making processes. The CIG is part of the [Center for Science in the Earth System](#) at the University of Washington's [Joint Institute for the Study of the Atmosphere and Ocean \(JISAO\)](#).

Spotlight (past Spotlight features)

- **(new) IPCC releases Summary for Policy Makers**
Read the latest conclusions regarding global climate change from the IPCC's 2007 Summary for Policy Maker's Report (2.3.07)
- **Monthly climate outlook updated**
Read the latest monthly climate outlook from the CIG (1.26.07)
- **Report on the economic impacts of climate change on Washington State released**
Read the report released by the Washington State Departments of Ecology and Community, Trade & Economic Development. [Read the press release](#) from the Department of Ecology (1.10.07)
- **Register for the 2007 Climate Prediction Applications Science Workshop**
The CIG is pleased to host the 2007 Climate Prediction Applications Science Workshop on March 20-23, 2007.
- **The PNW Climate CIGnal Issue 8 posted**



Pacific Northwest. The Climate Impacts Group focuses on the Columbia River basin (shaded) and the states of Washington, Oregon, and Idaho.

Institutional Resources

- Climate Impacts Group – NOAA RISA

- Edward Miles, National Academy Member
- Phil Mote
- Nathan Mantua
- Dennis Lettenmaier
- Alan Hamlet

- JISAO

- Department of Civil & Environ. Engineering

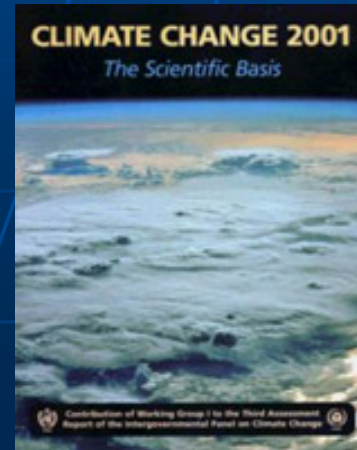
- Andrew Wood

- Atmospheric Sciences

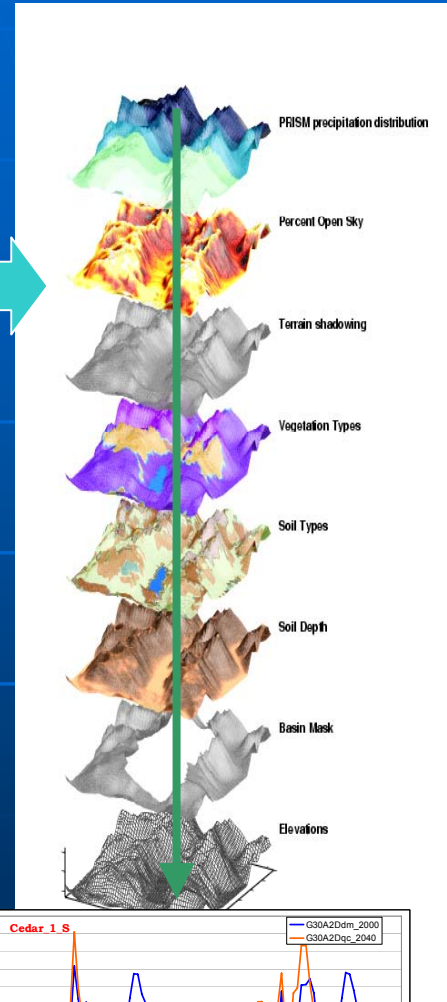
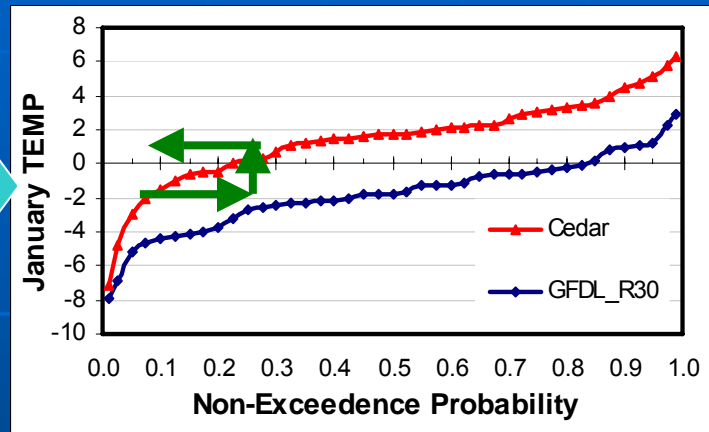
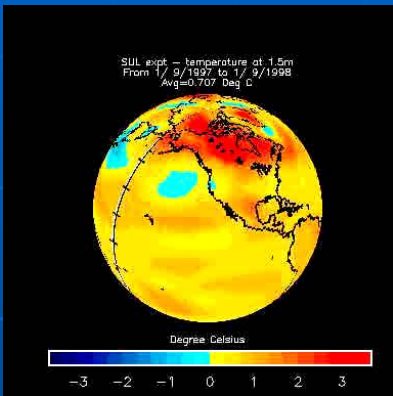


General Approach to Evaluating Impacts of Climate Change

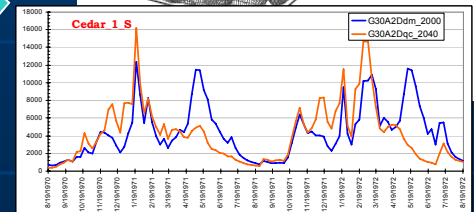
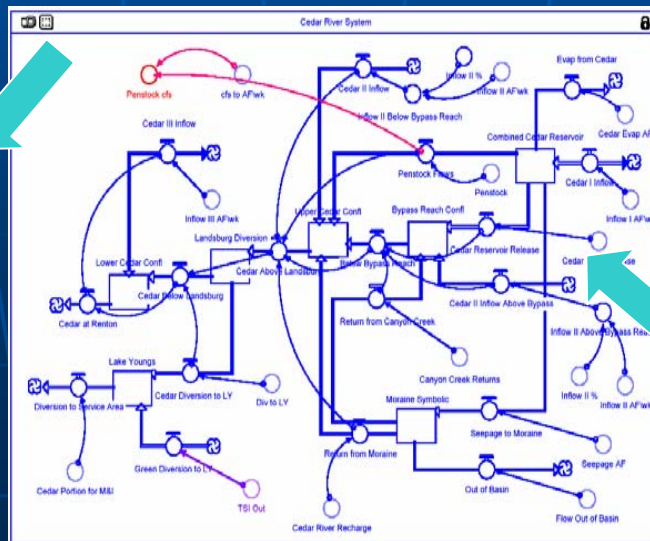
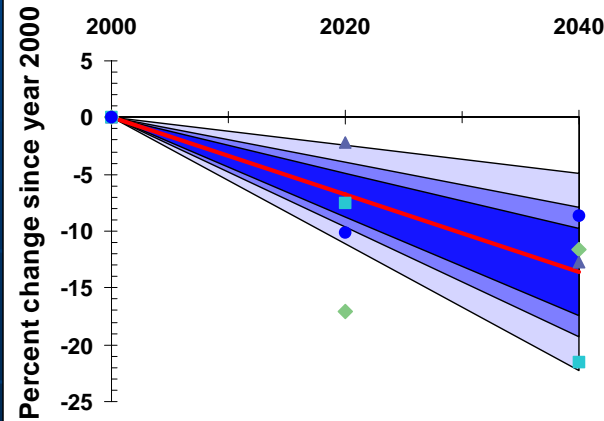
- Climate change impacts on water resources are recognized as extremely important.
- An understanding of hydrology and water resources management is essential
- An integrated approach, across sectors is needed
- Apply best science available



Impact Assessment Method



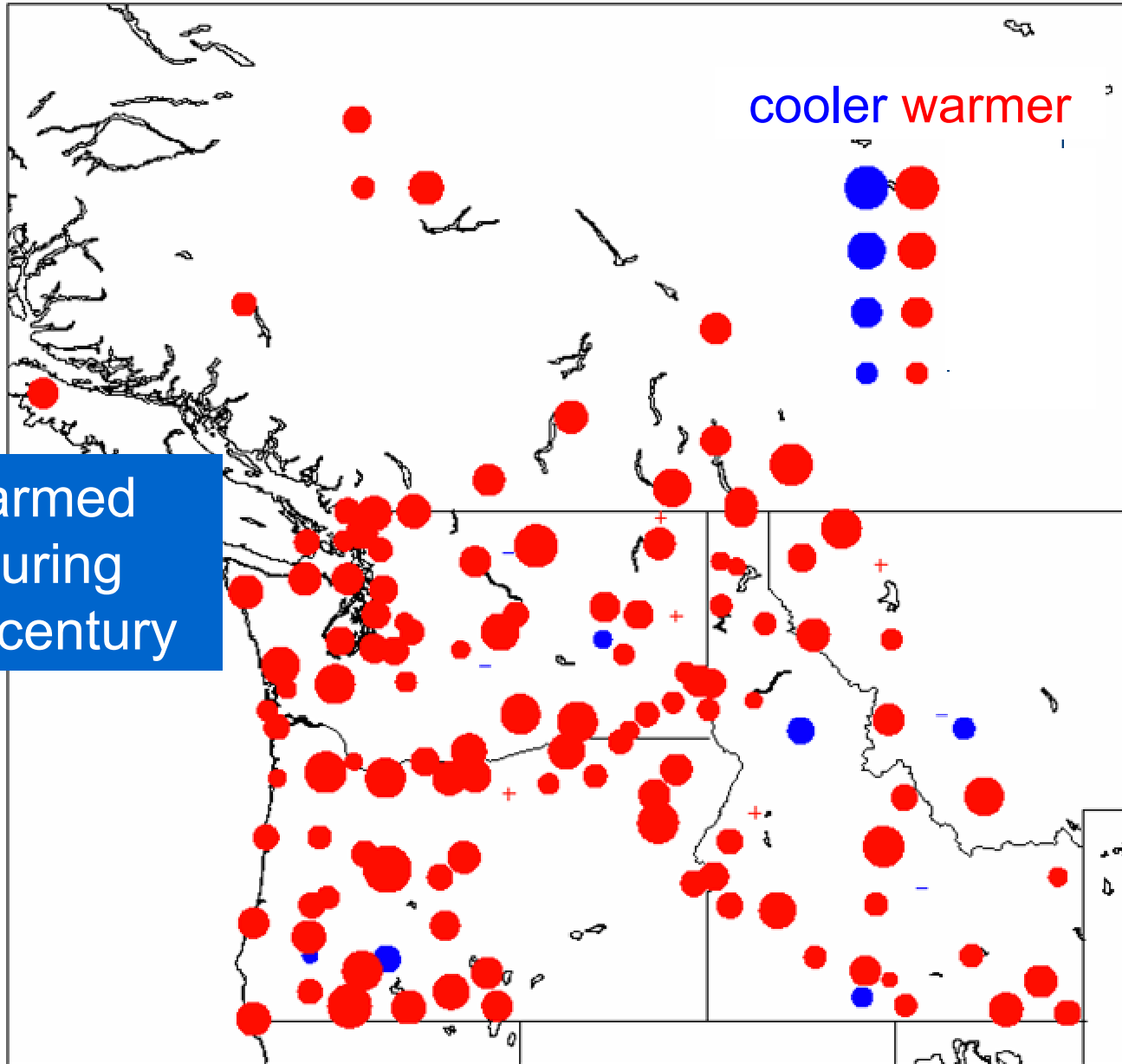
Rate of Change in Gross Yield as percent of GCM's year 2000 values



Pacific Northwest Studies

- Columbia River Basin
- Seattle Water Supply
- Portland Water Supply
- Salmon Recovery in the Snohomish

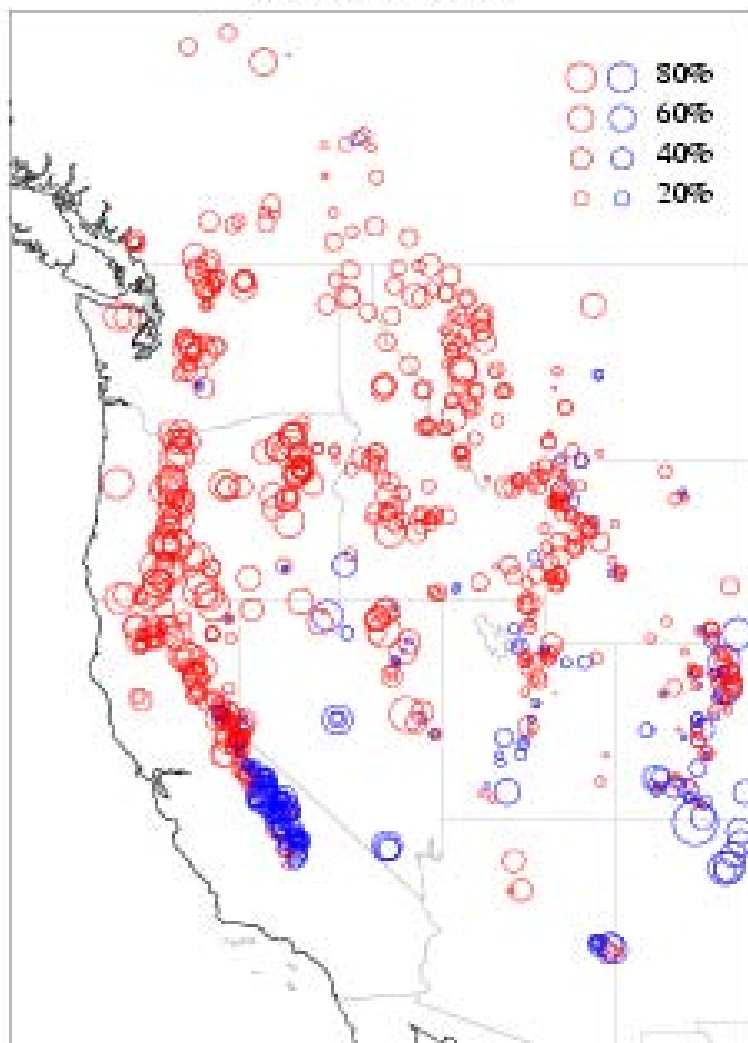
Temperature trends (°F per century) since 1920



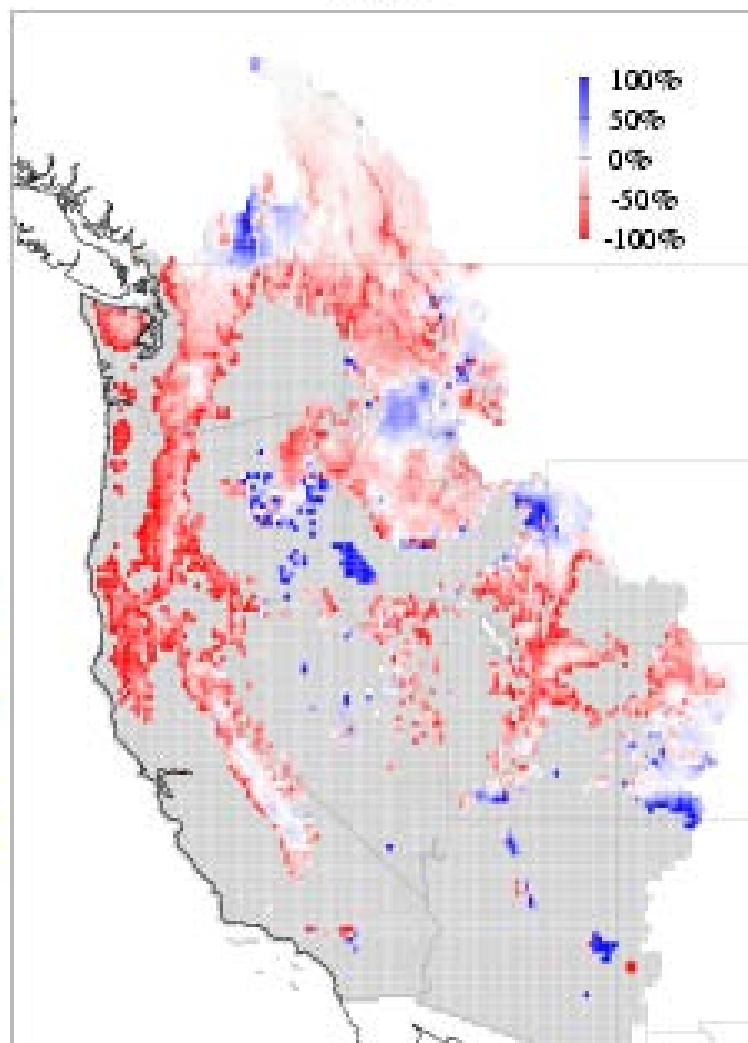
PNW warmed
+1.5 F during
the 20th century

Trends in April 1 SWE 1950-1997

a. Observations



b. VIC



Portland Water Supply Climate Change Study

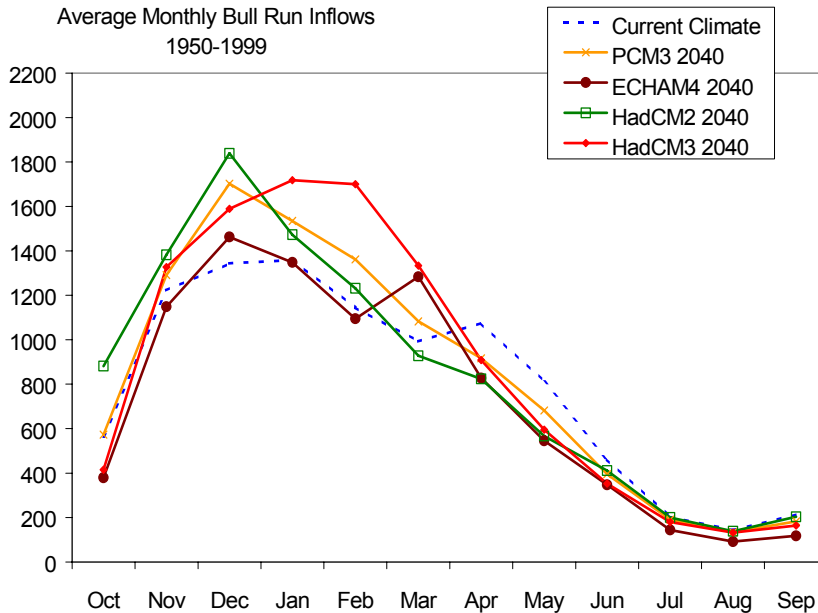


2040s WATER NEEDS IN PORTLAND (OR):

Regional growth: +40 mgd
 Climate change: +20 mgd

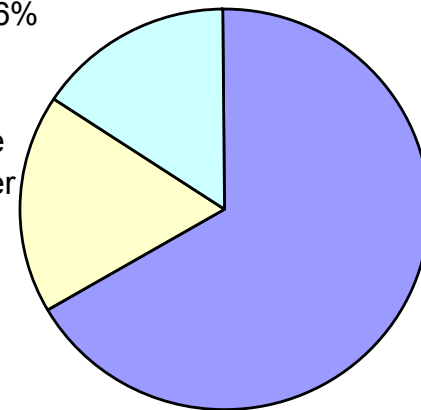
Climate change impacts = 50% of growth impacts

Average Monthly Bull Run Inflows
 1950-1999



Climate change
 impacts on water
 supply
 16%

Climate change
 impacts on water
 demand
 18%



Impact of population
 growth on demand
 (no climate change)
 66%

Seattle Climate Change Study

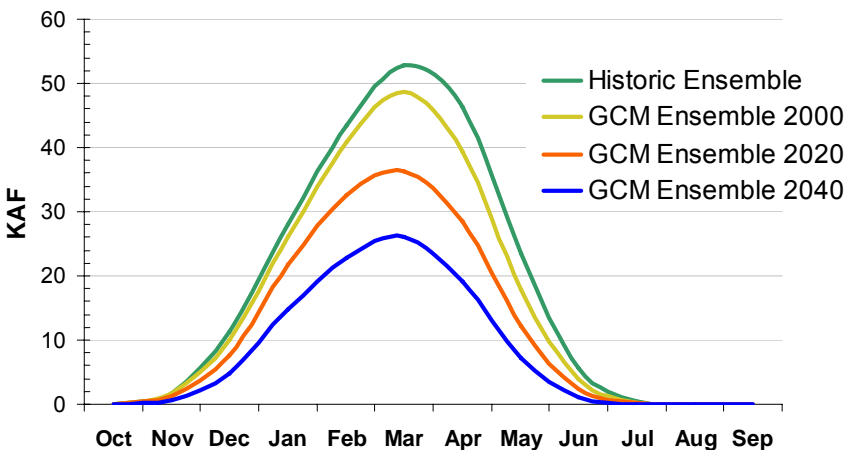


2040s Climate Impacts SEATTLE (WA):

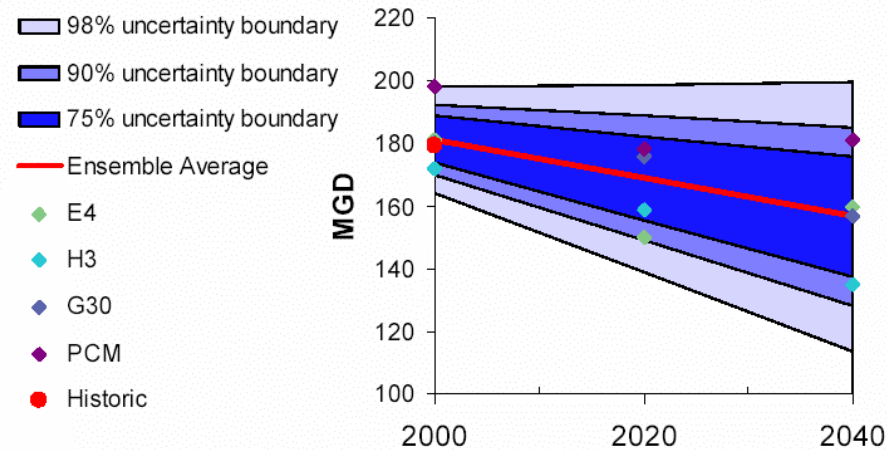
Decreasing Snowpack: -50%
Loss of Gross Yield: \approx 20 mgd

System water demand has decreased!

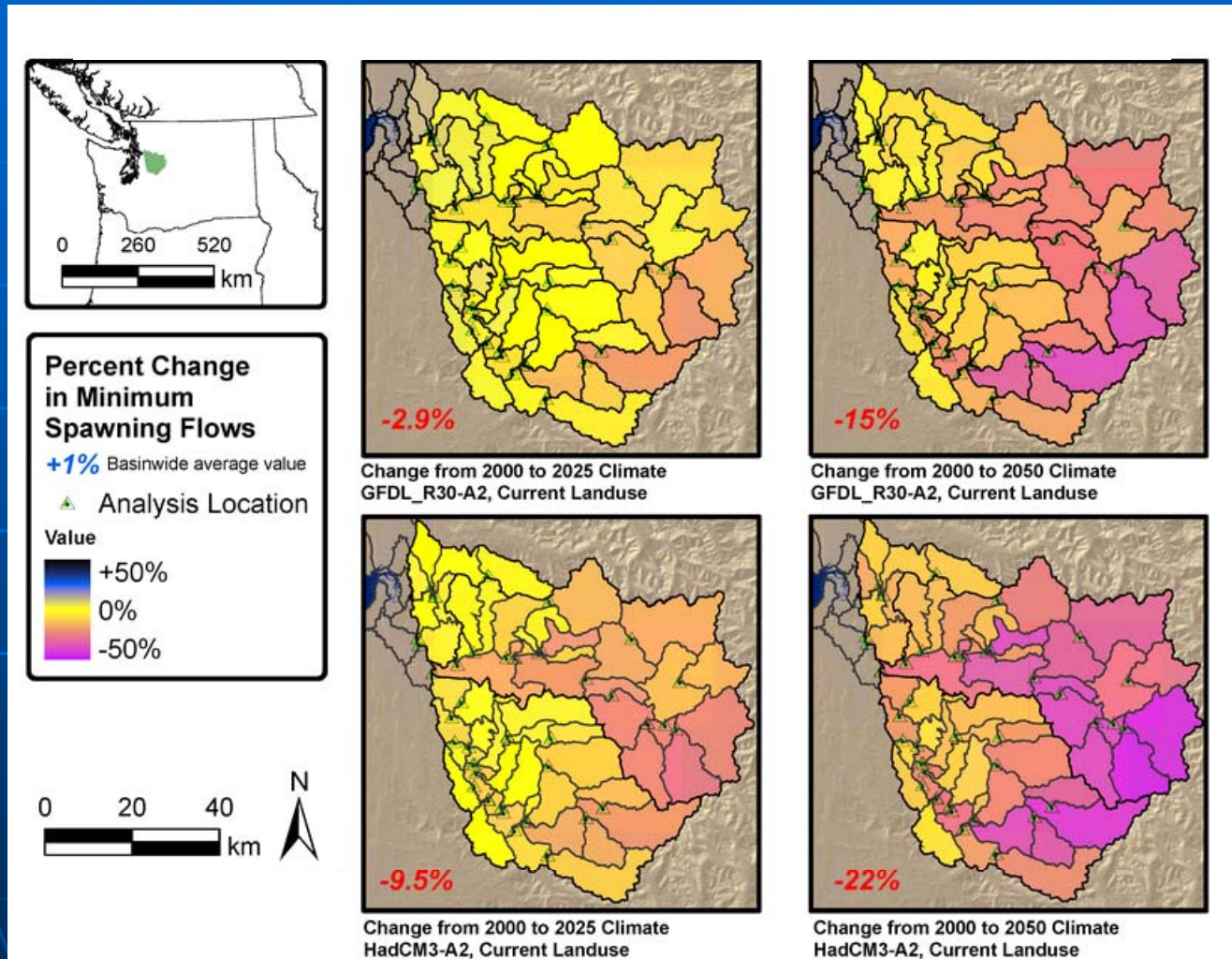
Average Annual System Wide Snow Storage



Trend in Gross Yield of the Seattle Water Supply System



Climate Impacts: Low Flow



Minimum spawning flow- lowest instantaneous flow between Sept. 15th and Nov. 15th

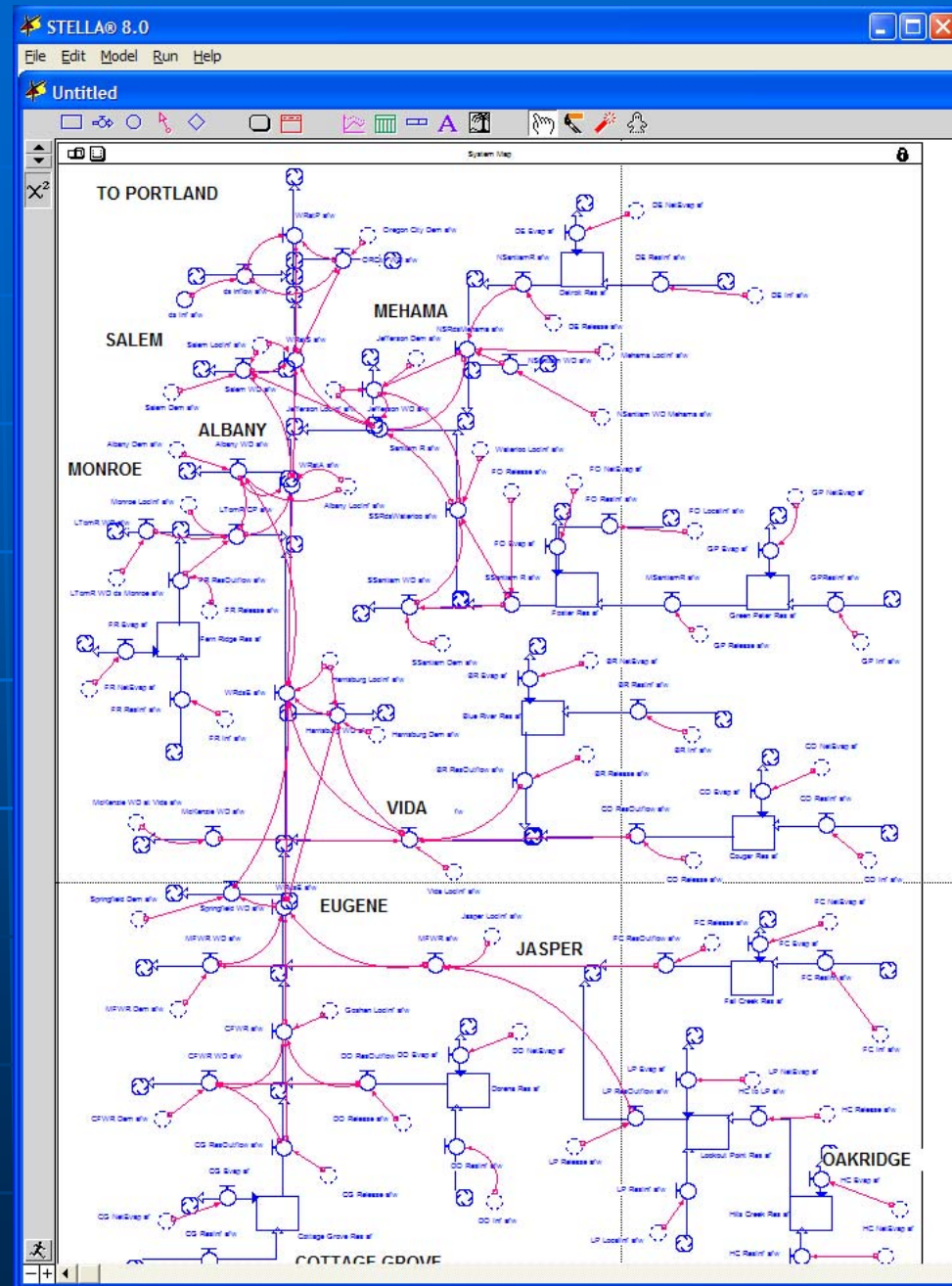
Average reductions in minimum spawning flows 15-22%

Some Other Study Areas

- Columbia River Basin
 - Primary Focus of CIG
 - Continental Scale Basin
- Sacramento-San Joaquin
- Colorado River
- Rio Grande
- ACT/AFT
- Others local, national, and international

■ Willamette River Operations Study

Eric Hagen
OR WRD



Climate Change Building Blocks

Goal – to develop a regional consensus among water resources professionals in the Puget Sound area concerning the impacts of climate change.

Part of an on-going Tri-County effort in water resources planning (King, Pierce, and Snohomish Counties)

Significant challenge in arriving at consensus

Building Blocks Document



- As with other science, our understanding will improve with time
- Uncertainties exist, but much is known

(Source:
<http://agexted.cas.psu.edu/FCS/mk/images/BuildingBlocks.jpg>)

Building Blocks

Areas of interest

- Global trends
- National trends
- Pacific Northwest trends
- Puget Sound Region

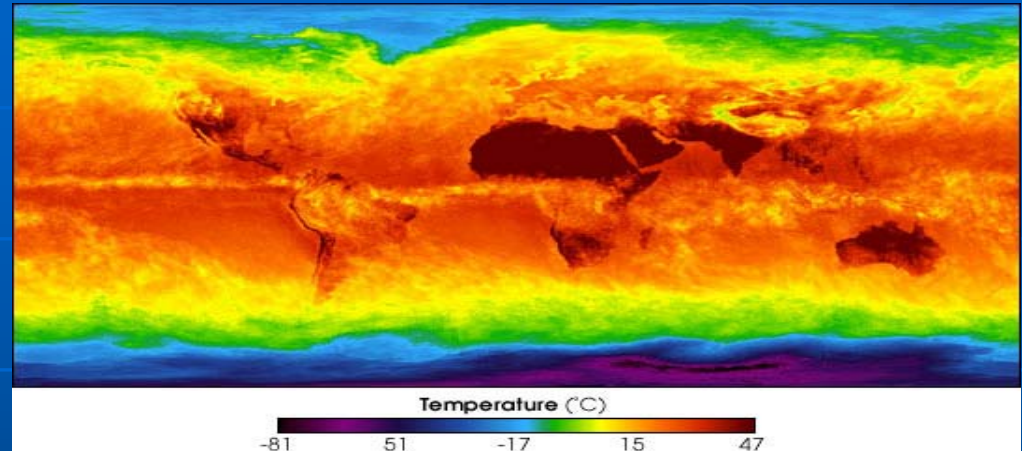


(Source: <http://www.afsc.org/locations/us/images/pacificNW.gif>)

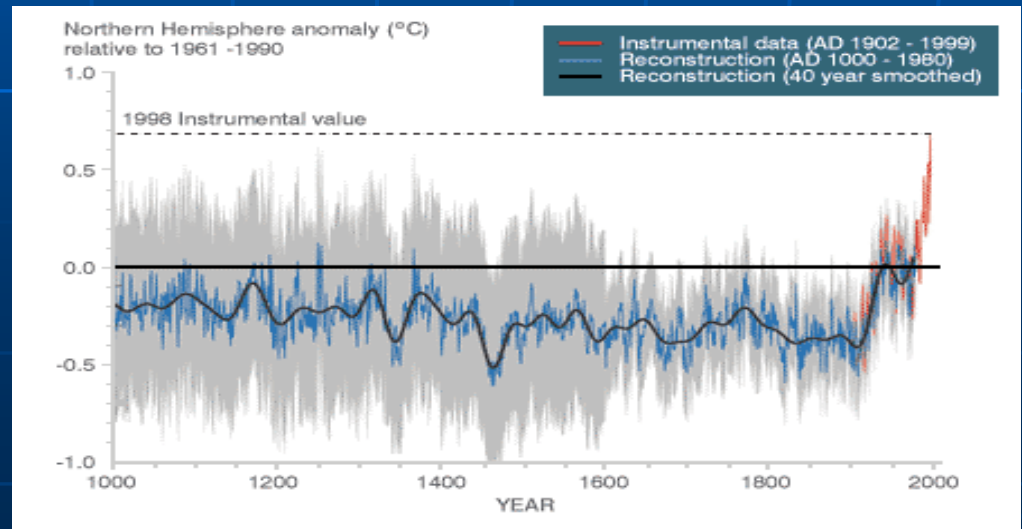
Impacts of Climate Change

Impacts organized into six areas:

- Temperature
- Precipitation
- Snowpack and Glaciers
- Streamflows
- Sea Level Rise
- Salmonid Habitat



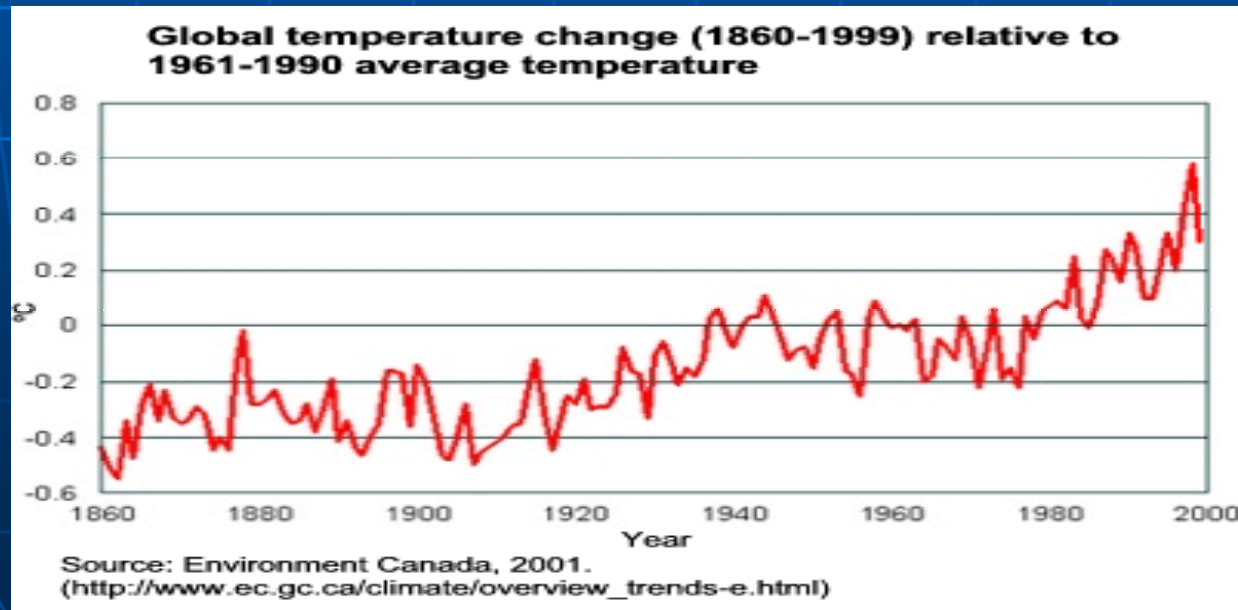
(Image courtesy [AIRS Science Team, NASA/JPL](#))



(Source: *IPCC Third Assessment Report*)

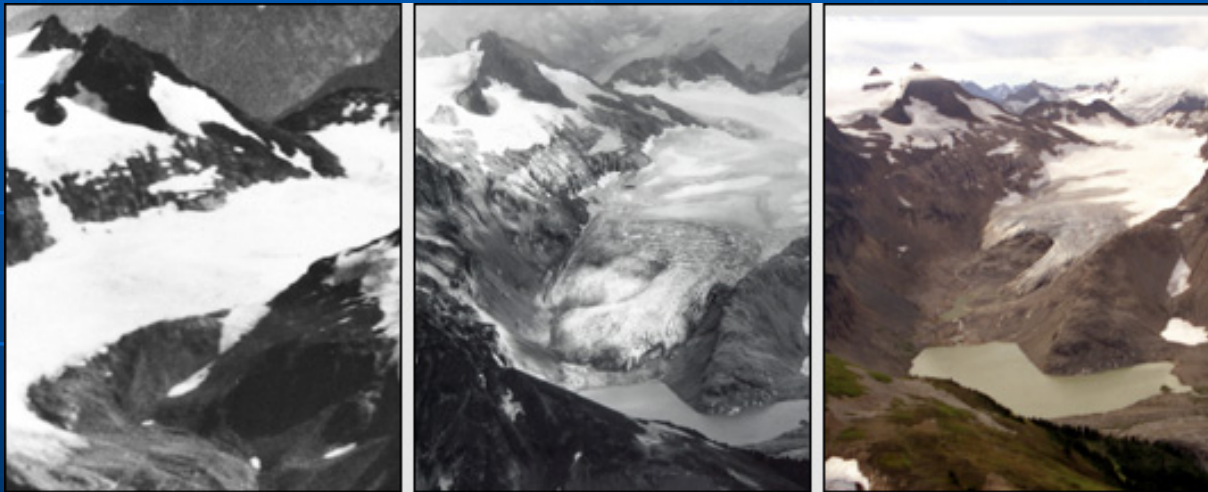
Building Block 1

- The global average temperature has increased during the 20th century and is forecasted to increase in the 21st century.
- “[T]he globally averaged surface temperatures have increased by $0.6 \pm 0.2^{\circ}\text{C}$ over the 20th century” (IPCC, 2001)



Building Block 6

- The loss of snowpack and glaciers in the Pacific Northwest mountains has been due to increased temperatures in the 20th century.



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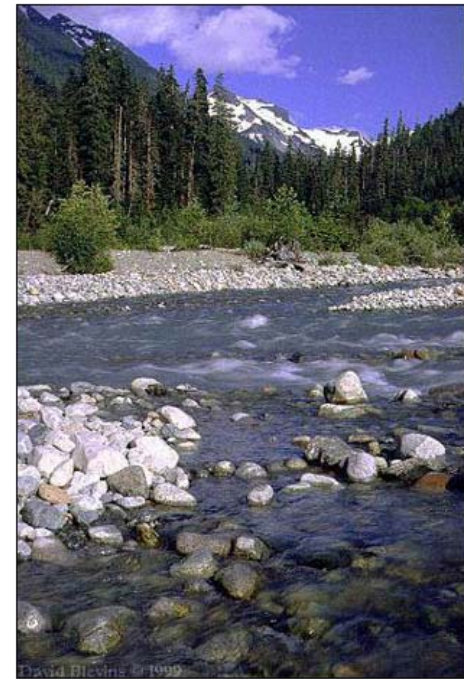
1928
South Cascade
Glacier,
Washington

1979
South Cascade
Glacier,
Washington

2003
South Cascade
Glacier,
Washington

Building Block 8

- Climate change is projected to increase winter flows and decrease summer flows in snowmelt influenced river systems of the Pacific Northwest, particularly transient watersheds.
- “Available evidence suggests that global warming may lead to substantial changes in mean annual streamflows, seasonal distributions of flows, and the probabilities of extreme high or low-flow conditions.” (IPCC, 2001)



Building Block 10

- Climate change is projected to increase the frequency of drought events in the Pacific Northwest.



(Source: www.ecy.wa.gov/programs/wr/drought/2005/images/photo/pic_1kroosevelt1.jpg&imgrefurl)

- “A change in mean flow or in variability could cause the physical infrastructure to be inadequate for the intended purposes or increase the risk of failure of the water resource system under extremes of drought or flood. In large water systems, such risks are buffered by robustness and resilience in the design of the system; smaller systems may be more vulnerable under climate scenarios beyond those considered in their design.” (IPCC, 2001)

Building Block 12

- Climate change is forecasted to increase temperatures of rivers, streams, lakes, and river mouth estuaries in the Puget Sound region.



- “Looking toward the future, global warming is almost certain to lead to additional [warming] of the surface waters of Puget Sound and its tributary rivers as a result of the projected increases in regional temperatures and decreases in summer stream flow.” (Snover, A. K., P. W. Mote, L. Whitely Binder, A.F. Hamlet, and N. J. Mantua. 2005.)

(Source: <http://www.veriscope.com/images/salmon-river-chinook-and-st.jpg>)

SPECIAL REPORT GLOBAL WARMING

TIME

**BE
WORRIED.
BE **VERY**
WORRIED.**

Climate change isn't some vague future problem—it's already damaging the planet at an alarming pace. Here's how it affects you, your kids and their kids as well

EARTH AT THE TIPPING POINT

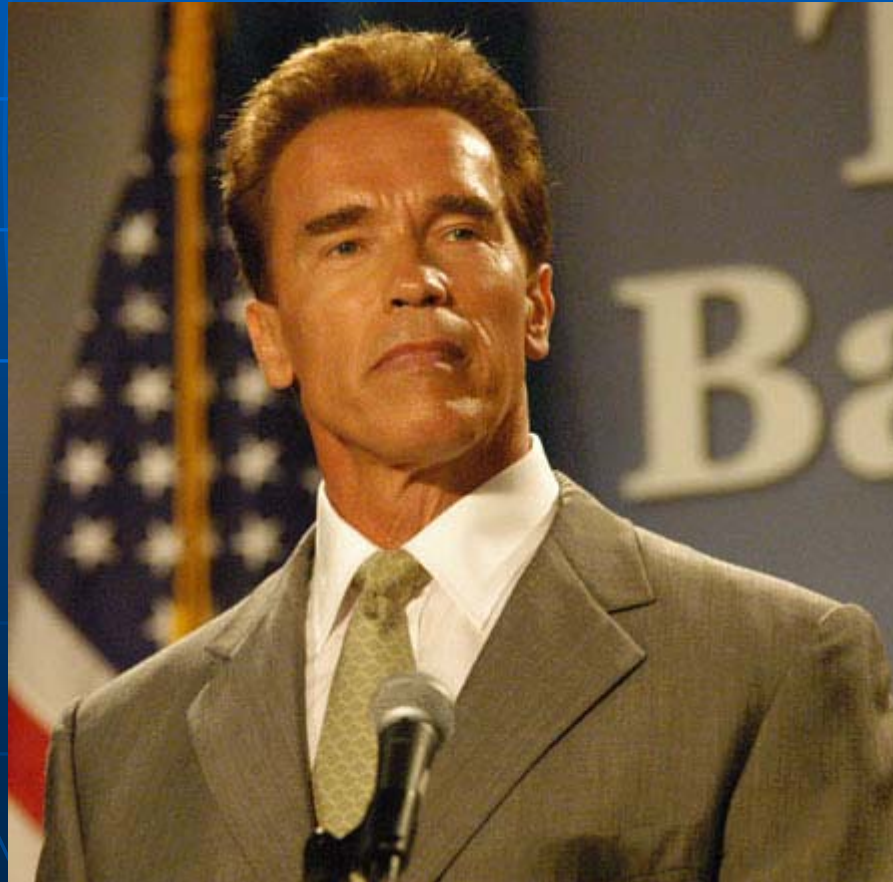
HOW IT THREATENS YOUR HEALTH

**HOW CHINA & INDIA CAN HELP
SAVE THE WORLD—OR DESTROY IT**

THE CLIMATE CRUSADERS



"I say the debate is over.
We know the science.
We see the threat.
And we know the time for action is now."
Governor Arnold Schwarzenegger, June 1, 2005



Conclusions

- Research on climate change indicates significant impacts
- Outstanding regional expertise in evaluating climate change
- Strategic Planning requires the “long view”
- Developing regret resistant alternatives is possible